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Simultaneous Communication by Inexperienced Signers: Effect of Fingerspelling Complexity on Temporal Characteristics and Perceived Naturalness of Speech[1]

Robert L. Whitehead, Nicholas Schiavetti, and Dale Evan Metz

Simultaneous communication (SC) that combines speech with manual signs and fingerspelling to produce each word of an utterance is often used to improve communication and enhance speech and language development of Deaf and hard-of-hearing children. Previous research (Huntington & Watton, 1984; Whitehead, Schiavetti, Whitehead, & Metz, 1995; Windsor & Fristoe, 1989, 1991) has indicated that speech produced during SC differs from speech produced alone (SA) in certain temporal features, including slower rate of articulation and increases in sentence, word, vowel, and interword interval durations. A similar slowing of speech occurs in mothers (*motherese*) or parents (*parentese*) when they speak to young children (Swanson, Leonard, & Gandour, 1992).

It is both theoretically and practically important to know if speech is merely slowed during SC or if the speech production process during SC actually violates the natural physiological constraints that underlie the temporal rules of spoken English. A mere slowing of speech would indicate that the speaker attempts to approach simultaneity by approximating speech rate to the slower manual task. But a violation of linguistic temporal rules would indicate that the manual task detracts from the communicative effectiveness of the speech task, possibly jeopardizing perception of speech or providing an inadequate model to a developing child with a hearing impairment.

During SC the communicator typically uses fingerspelling for words for which there are no signs. Such fingerspelled words are often multisyllablic or composed of many letters and therefore more challenging to produce than signs. Akamatsu and Stewart (1989) reported that it is difficult for both children and adults to learn to fingerspell and speak simultaneously due to the demanding task of coordinating manual orthographic patterns with articulatory speech patterns.

Schiavetti, Whitehead, Whitehead, and Metz (1998) examined the systematic effects of fingerspelling task difficulty (indexed as four graduated levels of fingerspelling task length) on the speech produced during SC by experienced signers. Results indicated longer durations in SC than in SA, and sentence and word durations increased systematically with increased fingerspelling task length. In addition, it was reported that speech during SC was perceived as significantly more unnatural than SA and perceived naturalness decreased systematically with fingerspelling task length in the SC mode.

No empirical research has been conducted to measure disruption of speech production characteristics or natural speech quality during SC by inexperienced signers who find fingerspelling difficult to learn. Because research on the external validity of the effects of fingerspelling task difficulty has not been reported, systematic replication is needed to determine the generalizability of the findings with experienced signers across persons with less signing experience such as parents, siblings, hearing peers, hard-of-hearing peers and less experienced classroom teachers who use SC.

The purpose of this study was to examine the effect of SC and the effect of increasing fingerspelling difficulty level on selected temporal characteristics and speech naturalness for inexperienced signers. Specifically, we studied the effects of two independent variables: (a) mode of communication (SA vs. SC) and (b) fingerspelling difficulty (indexed as four graduated levels of fingerspelling task length from low to high) on six dependent variables: (i) sentence duration, (ii) experimental word duration, (iii) diphthong duration in the word preceding the experimental word , (iv) interword interval duration preceding the experimental word, (v) interword interval duration following the experimental word, and (vi) rated speech naturalness.

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[1]*The complete report of this study is under review for publication in a professional journal.*

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This issue of the *Bulletin* focuses on speech and writing. In the first article, Dr. Robert Whitehead and colleagues report on the latest in a series of investigations on the quality of speech when it is combined with signing. Their findings are important to caregivers and educators who have long been concerned about the speech models that deaf children perceive in simultaneous communication. The second article by Dr. Kathryn Schmitz summarizes her investigation of students' perceptions of literacy instruction in college. These findings suggest ways of improving writing instruction for this group of highly motivated college students.

We hope you find these reports informative and useful. If you are curious about research being conducted on other topics, please visit our new website (*http://www.ntid.rit.edu/research*) and try out the new search capabilities. As always, we welcome your comments and suggestions. Just click on the highlighted text, *suggest considerations*, on the research home page.

John A Albertini

Method

Speakers for this study were 8 hearing adult females who had recently completed a one-semester beginning course in sign language.

The speech samples investigated consisted of the carrier sentence, "I can say _____ again," and 16 experimental words embedded in the blank slot of the carrier sentence. In the SC condition, the carrier sentence was signed while the experimental words were fingerspelled. Four groups of four experimental words each, with each group consisting of words of increasing fingerspelling task length, were used as an index of fingerspelling difficulty. Each group began with an initial base word to which three suffixes of increasing length were added to increase the base word's length. The stimulus material consisted of the four based words, *care*, *trust*, *truth*, and *talk* and their expansions into words with suffixes (e.g., *care, careless, carelessly, carelessness*; *trust, trustful, trustfully, trustfulness*; *truth, truthful, truthfully, truthfulness*; *talk, talkative, talkatively,*

talkativeness). This task is similar to Lehiste's (1972) classic study of utterance timing, in which she found that addition of longer suffixes increased whole-word utterance length while decreasing the length of the base word within the whole word.

The SA and SC sentences were audio recorded. Each recorded sample was digitized using a Kay Elemetrics Computerized Speech Lab in order to make temporal measurements of the acoustic signals. Temporal measures were made of sentence duration, word duration, diphthong (before the experimental word) duration, and durations of interword intervals (IWI) before and after the experimental word. In addition, forty students in the Department of Communicative Disorders and Sciences at the State University of New York at Geneseo scaled their perception of speech naturalness of the 32 sentences (4 word groups x 4 levels of fingerspelling task length x 2 experimental conditions) using a 9-point interval scale, where 1 is highly natural and 9 is highly unnatural sounding speech.

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Table 1.
Means and standard deviations (SD) of the five temporal variables and speech naturalness during speech alone and simultaneous communication conditions at four different levels of fingerspelling task length (e.g., care, careless, carelessly, carelessness*). All temporal durations are in milliseconds. IWI = Interword Interval. Speech naturalness is on a 1 to 9-point interval scale with 1 equal to most natural and 9 most unnatural.*

		Sentence Duration	Word Duration	Diphthong Duration	IWI Before Duration	IWI After Duration	Speech Naturalness
Speech Alone Condition							
Fingerspelling Task Length							
1	Mean	1509	417	153	83	75	2.08
	SD	134	81	50	21	51	0.93
2	Mean	1720	582	160	81	73	2.06
	SD	141	34	52	27	50	0.86
3	Mean	1849	721	169	78	77	2.22
	SD	175	53	61	31	58	1.01
4	Mean	1894	761	173	79	74	2.38
	SD	120	57	52	29	38	0.95
Simultaneous Communication Condition							
Fingerspelling Task Length							
1	Mean	4252	633	360	1009	987	5.89
	SD	890	112	33	392	602	0.99
2	Mean	6093	2018	357	1044	284	6.83
	SD	1240	967	35	394	760	0.95
3	Mean	6890	2773	345	1092	1500	7.10
	SD	1215	1532	53	438	1339	1.22
4	Mean	8246	3439	351	1384	1812	7.71
	SD	1918	1490	52	396	1605	0.72

Results

The results of this experiment are illustrated in *Table 1*, which shows the means and standard deviations of the dependent variables in each of the experimental conditions. In general, examination of *Table 1* reveals that each of the dependent variables was longer in duration and speech was judged as more unnatural in the SC condition as compared to the SA condition. In addition, in the SC condition, as fingerspelling task length increased there was a fairly systematic corresponding increase in sentence duration, word duration, IWI before duration, IWI after duration, and in the unnaturalness of the speech.

With respect to sentence duration, statistical analysis revealed that SC was significantly ($p < 0.0001$) longer in sentence duration than SA for all task length levels. In addition, post-hoc testing revealed significant differences between fingerspelling levels 1 and 2 and between levels 2 and 3 for both SA and SC, but no significant differences between levels 3 and 4 for either condition.

Statistical analysis of word duration revealed that SC was significantly ($p < 0.01$) longer for all task lengths when compared with the SA condition. In addition, post-hoc testing revealed significant differences between levels 1 and 4 and between levels 2 and 4 of fingerspelling task length for SC but no significant differences among the levels for SA.

Diphthong duration for the word *say* was significantly ($p < 0.0001$) longer in the SC condition when compared with the SA condition. However, diphthong duration did not vary systematically with fingerspelling task length.

It was also determined that SC was significantly ($p < 0.0001$) longer in the duration of the interword interval before the experimental word than during SA for all task length levels and that interword interval duration before the experimental word increased systematically with increased fingerspelling task length. Post-hoc testing revealed significant ($p < 0.01$) differences between levels 1 and 4 and between levels 2 and 4 of fingerspelling task length for SC but no significant differences among the levels for SA.

Statistical analysis also revealed that SC was significantly ($p < 0.01$) longer in the duration of the interword interval after the experimental word than during SA for all task length levels. Further, interword interval after the experimental word did not appear to vary systematically with fingerspelling task length.

With respect to speech naturalness, it was found that SC was significantly ($p < 0.0001$) rated more unnatural on the speech naturalness scale than SA for all fingerspelling task lengths. Further, speech became more unnatural as fingerspelling task length increased. Post-hoc testing revealed that in the SC condition there were significant differences between level 1 and level 4 fingerspelling task lengths and between level 2 and level 4 fingerspelling task length but no significant differences between levels 3 and 4.

Discussion

These results demonstrate a consistent pattern of significantly increased sentence, word, diphthong, and interword interval durations as speakers move from the SA to the SC condition. In addition, sentence, word, and interword interval before the experimental word all showed significant increases with increased fingerspelling task length. The present experimental findings are consistent with previous results that have shown elongated temporal speech characteristics when signed English and fingerspelling are combined with speech in SC by both experienced and inexperienced signers. Thus, because SC attempts to coordinate the rapid speech production act with the slower sign production act (fine motor versus gross motor activity), combining the two communication modes results in a slowing of the more rapid speech act to maintain simultaneity with the slower signing act.

Although the pattern of increased durations was very similar to that shown by experienced signers, the absolute values of the duration increases were much larger for the inexperienced signers, who showed greater mean lengthening of sentences, words, and interword intervals before and after the experimental word to be fingerspelled than for the experienced signers during SC on the same task (Schiavetti et al., 1998). They also showed larger standard deviations in these measures than experienced signers, except for diphthong duration. These findings indicate not only greater overall temporal elongation of segments and pauses for inexperienced signers, but also more variability among inexperienced than among experienced signers.

The performance difference between inexperienced and experienced signers in anticipation of the experimental word to be fingerspelled was also interesting with respect to the difference between the elongation patterns of the diphthong and the interval before the fingerspelled word. For both variables the inexperienced signers showed more than double the elongation of the experienced signers, but the inexperienced signers showed much less variability in diphthong duration and much more variability in interword interval variability than the experienced signers. These results indicate that all the inexperienced signers were slowing down their speech more on the diphthong in anticipation of the fingerspelling task but that some of them were taking much longer pauses before the experimental fingerspelled word. Possibly, those were the participants who were fingerspelling during the pause rather than during the word itself. Perhaps this was a strategy to catch fingerspelling up with the spoken word as a method of salvaging simultaneity.

The inexperienced signers' greater uniformity in lengthening the diphthong duration and their more varied approach to the interword interval in anticipation of the fingerspelling tasks again agrees with our anecdotal evidence that some inexperienced signers paused before the target word and fingerspelled the word in silence and then said the word. These anecdotal observations need to be explored in future research with video recording of the signers in order to confirm the possibility that at least some inexperienced signers are fingerspelling during pause time rather than during the actual fingerspelled word.

If this pattern of fingerspelling during pause time is confirmed, it may shed light on the learning process of both fingerspelling and SC. It is interesting to note that Akamatsu and Stewart (1989) found that "hearing people learning to sign report that it is very difficult to learn fingerspelling" and that Wilcox (1992) found that learning to read fingerspelling was rated as the most difficult learning task by hearing adults enrolled in a sign language course. Akamatsu and Stewart (1989) also noted that the demanding task of coordinating manual orthographic patterns and articulatory speech patterns may present sequential conflicts for SC users that further increase the difficulty of fingerspelling and speaking simultaneously. Thus it would not be surprising if inexperienced signers need to fingerspell during pause time as they learn to use SC but later fingerspell more rapidly as they become more fluent in both manual communication and SC. It is possible that, as inexperienced signers mature into experienced signers, their increased rapidity of fingerspelling develops into increased simultaneity with the spoken word in SC.

Critical issues for future research include learning (a) the amount of time and practice that are necessary to become fluent enough in SC to fingerspell and speak simultaneously and (b) what strategies might be used by beginning signers to develop fluency in SC. Video recording of both inexperienced and experienced signers' performance on these tasks would be important in further investigations of the effects of fingerspelling task difficulty on speech characteristics during SC to provide better generalization to the demands of real-world simultaneous oral and manual communication.

Future research concerning SC with inexperienced signers needs to take a longitudinal approach in studying the development of sign and fingerspelling skills as they are integrated with speech in SC. Of great importance is the issue of how family members and other significant persons in the language learning environments of Deaf and hard-of-hearing children are learning manual communication and what training strategies are most effective for helping them to communicate more efficiently through SC as their manual skills develop. Questions concerning the rate of manual skill development, learning strategies employed by new signers, and teaching strategies used by sign language teachers and the influence of these factors on the quality of speech, sign, and fingerspelling are very complex issues that will require multivariate research designs. Such data are important for the development of recommendations for the ongoing learning and use of SC by persons with newly acquired manual communication skills. These recommendations should enhance the communicative effectiveness of all members within the Deaf or hard-of-hearing child's environment.

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The Academic English Literacy Acquisition Experiences of Deaf College Students

Kathryn L. Schmitz

Research focusing on the experiences, as opposed to the performance, of deaf students within a hearing academic English environment is limited. There is little documentation of what deaf and hard-of-hearing students experience in academic English contexts in college. Some studies address the feelings of general disenfranchisement experienced by such students in mainstream college situations, but these ethnographies do not explore the actual phenomena of what takes place in such situations, nor do they permit the student participants to define the meanings of the phenomena. They do not describe the participation of these students as they negotiate the process of attempting to become literate citizens in school.

This gap led me to the primary research question for this phenomenological study (Schmitz, 2008): What are the narrated English literacy acquisition experiences and practices of a group of deaf and hard-of-hearing students in college? The corollary research question was: How does this narration inform us about students' perceptions of academic English literacy acquisition?

The purpose of this study was to describe deaf college students' perceptions of their experiences learning academic English literacy. In it, I examined the narrated experiences and practices of 11 deaf and hard-of-hearing students at RIT. Through paradigmatic analysis of narrative data, I located common themes that revealed the students' perceptions of academic English literacy acquisition.

Methods employed in the study were phenomenological interviewing and recursive analysis. Primary data sources were participant interviews and a focus group, which were videotaped. In both settings, I wore a microphone.

During the focus group, two certified sign language interpreters voiced what the participants signed. The interviews and the focus group discussion were carefully transcribed.

The data were analyzed recursively. That is, reading the transcripts repeatedly, I identified themes and meanings and then confirmed my interpretation of them. In this way, I identified three categories. The first consisted of pre-college literacy experiences and beliefs about literacy learning, activities that took place in college English courses, and obstacles perceived to limit participants' progress through the academic English system. The second consisted of assistive and collaborative learning experiences discussed by participants as well as the roles of their deaf peers in these experiences; and the third consisted of participants' perceptions of instructors, expectations, and teaching methods.

I concluded that participants 1) struggled to find the right balance between working with assistance and working independently; 2) preferred instructors who were highly competent communicators, and these tended to be deaf instructors; 3) observed a difference in the kind of assistance they received within their own college and the larger university; 4) preferred learning environments that were more visually accessible, such as group discussions with peers who also signed; and 5) encountered conflicts that restricted their learning, ranging from communication barriers to unclear or rigid expectations to internal contradictions between challenge and remediation.

Some participants who relied on tutoring also experienced mixed messages from teachers of the upper level courses, who communicated an expectation that students would do their work independently. This created a tension between participants' need for continued assistance in improving their skills and instructors' expectation that participants would create acceptable work without assistance.

Many participants preferred deaf teachers because of clearer communication, more effective instruction,

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Notes of Note

James Mallory and **Victoria Robinson** presented a paper (co-authored with **Gary Long**) "Using Second Life® to Enhance Student Learning of Technical Concepts" at the March 2010 conference of the American Society for Engineering Education held at RIT. Jim presented in person, while Vicki presented from within the 3D world using her avatar.

In March, **Gerald Berent** and **John Albertini** presented a paper (co-authored with **Ronald Kelly** and **Rose Marie Toscano**), "Deaf students' knowledge of English verbs' argument and event

properties," at the annual convention of Teachers of English to Speakers of Other Languages in Boston. They described deaf college students' lexical knowledge of subtle properties of English verb structures and the implications of this knowledge for successful reading comprehension and written expression in English.

Harry Lang's *Edmund Booth, Deaf Pioneer* (2004, Gallaudet University Press) was recently selected for the "Deaf America Reads" project. Born 200 years ago, Booth was a co-founder of the National Association for the Deaf in 1880.

shared experiences, and cultural affinity. One participant explained:

> Because I felt more comfortable with the deaf teachers because we had shared background. Yeah! And I felt that they respected my level of English, and they helped me better…. They helped me better related to their method of instruction, which was influenced by their deafness. They taught by example. They did more expansion. It was visually accessible.

Several participants observed that the faculty and tutors who work with students at the associate degree level are more rigorous in focusing on students' English grammar, whereas those who work with baccalaureate-level students focus more on the academic concepts and subject matter. According to one participant:

> Some of the teachers at the NLC [NTID Learning Center] or some of the RIT instructors may look at the English and say okay, that's good enough. And some of the NTID people may correct it and edit it much more aggressively. I mean I understand that it is a deaf college, and the English teachers have high expectations and want to push the deaf students to improve their English skills. So, they may grade even more strictly. At the same time, the students may get really turned off by that because they feel like they are always doing it wrong.

Some participants felt strongly that deaf students were limited in their options for academic advancement through the English course system at the university and were prevented from progressing through the curriculum effectively and attaining their desired degrees. Examples of limitations included inappropriate course placement (resulting in courses that were not challenging), course sequences that took too long to complete, conflicting messages to students from different departments, different teaching approaches that confused students, course assignments that seemed irrelevant or unrelated to students' experiences, insufficient time to complete homework or tests, or rules that were perceived to tbe arbitrary or silly.

Participants essentially argued for a redefinition of the literacy expected in their college English classes to that of what Kliewer (1998) refers to as "construction of shared meaning in specific contexts." Their position seemed to be that in an environment designed to promote access and opportunities for deaf people, the standards of achievement and associated definitions should be reconsidered in a manner that supports deaf students' achievement in meaningful ways. Instead of focusing almost exclusively on isolated subskill mastery in written communication, teachers could recognize student production and apply that to help students construct written language they may use "to solve problems, accomplish learning goals, express emotions, empathize with peers, gather and convey information, form friendships, and resolve conflicts (Kliewer, 1998)."

I conclude the study by showing how understanding deaf college students' perceptions of academic English literacy acquisition may inform and improve teaching practices with this population, especially with regard to promoting proficiency in the dominant literacies of school and work.

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Peter Hauser, **Daphne Bavelier** (University of Rochester), and **Matt Dye** (University of Illinois-Urbana-Champaign) recently published, "Is visual selective attention in deaf individuals enhanced or deficient? The case of the Useful Field of View" (available online at *http://www.plosone.org*). They found that deafness alone, not sign language experience, is responsible for the enhanced peripheral visual attention found in deaf individuals and also that this allocation of attention to the periphery becomes apparent at 11 to 13 years of age.

Lisa Elliot, **Michael Stinson**, and **Pamela Francis** recently presented, "C-Print Tablet PC Support for Deaf and Hard of Hearing Students," at the International Conference of Education, Research and Innovation in Madrid, Spain.

Gerald Berent, Ronald Kelly, and **Tanya Schueler-Choukairi** recently published "Economy in the acquisition of English universal quantifier knowledge: Sentence interpretation by deaf and hearing students and L2 learners at the college level," in the journal, *Applied Psycholinguistics*.

A Particpant's Perception

In this excerpt, one student describes the experience of working with instructors who teach primarily deaf students and those who teach primarily hearing students.

"Some of the teachers at the NLC [NTID Learning Center] or some of the RIT instructors may look at the English and say okay, that's good enough. And some of the NTID people may correct it and edit it much more aggressively. I mean I understand that it is a deaf college, and the English teachers have high expectations and want to push the deaf students to improve their English skills. So, they may grade even more strictly. At the same time, the students may get really turned off by that because they feel like they are always doing it wrong."